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(54) MIXER

(71) We, GEBRS. TER BRAAK B.V., of No. 105—111, Thurledeweg, Rotterdam, Holland, a body corporate organised and existing under the laws of The Netherlands,

do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to apparatus for mixing two or more fluids, such as liquids, gases or pastes.

According to the present invention there is provided apparatus for mixing two or more fluids, comprising, an elongate tubular casing having a through-bore of substantially uniform cross-section throughout a major extent of its length, at least one pair of helically twisted strips, one strip being twisted in a right-hand direction and the other strip being twisted in a left-hand direction, said strips being disposed in side-by-side nested and interfitted relation whereby to define fluid flow paths which periodically merge and then separate along the length of said strips; said strips being housed within said casing within the section thereof which is of substantially uniform cross-section and said casing enclosing the strips whereby to confine said fluid flow paths and enhance intermingling and mixing of fluids passing therethrough.

Such an apparatus, while being of simple construction, has a high mixing efficiency. When two or more fluids, such as two liquids or a liquid and a gas, are passed together through the casing, the fluid streams will repeatedly be divided into partial streams which are by-passed, accelerated, retarded, combined and again divided and brought together, thanks to the interengaging portions of the helically twisted strips. As a consequence, there results an especially good mixing and kneading operation which leads to the formation of a homogeneous mixture in a relatively short length of the mixer. The pressure drop along the device is small and it can be cleaned by passing cleaning fluids through it. When maintenance is due, the device may easily be dismantled.

Some embodiments of the invention will now be described, by way of examples, with reference to the accompanying drawings, in which:—

Figure 1 is a longitudinal section through a first embodiment,

Figure 2 is a cross-section taken along the line II—II of Figure 1,

Figure 3 is a longitudinal section through a second embodiment, and

Figure 4 is a cross-section taken along the line IV—IV of Figure 3.

The embodiment of Figures 1 and 2 comprises a casing in the form of an elongated hollow tube 1, e.g. of stainless steel or of a transparent rigid synthetic resin. The tube 1 has an open inlet end 2 and an open outlet end 3. The ends 2 and 3 are each provided with an internally screw-threaded portion 4, 4^1 respectively for connection with pipelines and other devices. The exterior of the tube 1 is circular in cross-section and the inside 6 of the tube is in the shape of two intersecting circles, i.e. 8-shaped, the inside of the tube merging into a circular shape at the ends of the tube.

Positioned stationary within the tube 1 are two elongated helically twisted strips 7 and 8, made e.g. from metal. One of these strips 7 is twisted left-hand and the other strip 8 is twisted right-hand. The twisted strips 7 and 8 extend, lying side-by-side, over the whole effective length of the inside 6 of the tube 1 and at all cross-sections along their length lie at an angle of 90° to each other (Figure 2). Moreover, the strips 7 and 8 are interengaged in such a way that they are substantially in contact with each other (Figure 2).

The helically twisted strips 7 and 8 are tightly enclosed by the tube 1 so as to leave substantially no clearance between the strips 7 and 8 and the inside 6 of the tube 1. In order to reach this situation, the centre distance between the two intersecting circles forming the 8-shaped inner surface of the tube (Figure 2) has been chosen to be only

slightly more than half the diameter of these circles plus once the material thickness of the strips 7, 8 as used.

The mixer may be manufactured by first sliding one of the twisted strips (e.g. strip 7) into the tube 1 and then introducing the other twisted strip (e.g. strip 8) by screwing it into its place.

During operation of this embodiment, two or more fluids such as two liquids or gases or a liquid and a gas or a paste with a thin-flowing liquid and/or a gas, are fed to the mixer through its inlet end 2 and after having passed along the whole length of the mixer, are discharged through the outlet end 3. The transmission through the mixer may be effected by pumping or by suction. When passing through the mixer, the fluid streams will repeatedly strike the edges of the twisted strips 7 and 8 and will be divided into partial streams thereby. The partial streams will follow their own path, taking left-hand turns and right-hand turns respectively (compare the arrows A, A^1 in Figure 1). During this flow, the partial streams will be exposed to retarding and accelerating influences by means of enlargements and obstructions in their paths and moreover, they will repeatedly be forced from the inside to the outside and from the outside to the inside of the available space. Where two partial streams meet each other, they are combined and where a combined stream impinges on the edge of one of the strips, it is again divided into partial streams. As a result of this complicated series of phenomena, an extensive mixing and kneading operation takes place and this operation proceeds over the entire length of the mixer so as to cause the material leaving the mixer to be complete homogeneously mixed provided that the mixer is of sufficient length.

The minimum length of the mixer required to bring about a homogeneous mixture depends on several factors such as e.g. the nature of the substances to be mixed and the mixing ratio, but may easily be determined in each particular case by experiments beforehand. In many cases, the mixer need not be any longer than about 20 to 30 centimeters when its highest internal diameter is 1 centimeter.

The embodiment of Figures 3 and 4 differs only slightly from the foregoing embodiment. In this case too, the apparatus comprises an elongated, hollow tube 1 having an inlet end 2 and an outlet end 3. The tube 1 is provided with internally screw-threaded portions 4, 4^1 for connection with pipelines and other devices and further with a cooling or heating jacket 11 which has connections 12, 13 for feeding and discharging a heating or cooling medium. In cross-section, the outer and inner circumferences 5 and 6 of the tube 1 are four-lobed whilst the connecting portions and the jacket have a circular shape.

Positioned stationary within the tube 1 are four elongated, helically twisted strips 7, 8, 9, 10 formed for example of metal, which have been twisted alternately left-hand (e.g. strips 7 and 9) and right-hand (e.g. strips 8 and 10). These strips extend, lying side-by-side, over the whole length of the tube 1 and form angles of 90° with each other in cross-section (Figure 4). Moreover, the strips are interengaged with each other without, however, the strips being in contact with each other completely in cross-section (Figure 4).

The twisted strips 7 to 10 are tightly enclosed by the tube 1 so as to leave substantially no clearance between the strips and the inner circumference 6 of the tube 1.

The mixer may be manufactured by pressing the four twisted strips into their interengaging position and then introducing the whole combination by a sliding movement into the tube. Thereafter, the connecting sleeves 4 and 4^1 and the jacket 11 may be positioned and fixed.

The embodiment of Figures 3 and 4 is used in the same way as the embodiment of Figures 1 and 2. Thanks to the four twisted strips, the same phenomena will occur but in an intensified way, thus causing a still more effective mixing operation. The jacket 11 may serve to bring about a rapid cooling or heating action during operation. A rapid removal of heat generated during the mixing operation may be of advantage for substances which are heat-sensitive such as egg white emulsions.

On the other hand, a heating action of the substances during mixing may also be advantageous sometimes; thus, by heating and mixing knocked up egg white with cooked sugar, there may be obtained a toffee mass which is much more aerated than the known mixtures in this field of the art (a specific weight of 0.6 to 0.8 instead of 1.4).

The correct length of the mixer of Figures 3 and 4 may again be determined by previous experiments but in most cases, a length of 20 to 30 centimeters for an inner diameter of 1.5 centimeters will be sufficient.

Many variants of the embodiments as shown are possible. Thus, the tube 1 of Figures 3 and 4 may also have a circular inner circumference 6 in cross-section. In that case, there will be somewhat more clearance between the twisted strips and the inner circumference of the tube but this clearance may be neglected in practice. Further the embodiment of Figures 1 and 2 may also be provided with a cooling or heating jacket for better control of temperature during the mixing operation.

WHAT WE CLAIM IS:—

1. Apparatus for mixing two or more fluids, comprising, an elongate tubular casing having a through-bore of substantially uniform cross-section throughout a major extent of its length, at least one pair of helically twisted strips, one strip being twisted in a right-hand direction and the other strip being twisted in a left-hand direction, said strips being disposed in side-by-side nested and interfitted relation whereby to define fluid flow paths which periodically merge and then separate along the length of said strips; said strips being housed within said casing within the section thereof which is of substantially uniform cross-section and said casing enclosing the strips whereby to confine said fluid flow paths and enhance intermingling and mixing of fluids passing therethrough.

2. Apparatus as claimed in claim 1, wherein the cross-section of said through-bore is in the shape of two intersecting circles.

3. Apparatus as claimed in claim 1, wherein there are two pairs of oppositely twisted strips, each pair being nested and interfitted and the two pairs being in side-by-side relationship.

4. Apparatus as claimed in claim 3, wherein said through-bore is of a four-lobed configuration in cross-section.

5. The apparatus as claimed in any one of claims 1 to 4, in which a cooling or heating jacket is provided around the casing.

6. Apparatus as claimed in claim 1 or claim 2, wherein at all cross-sections along their length the strips are disposed at 90° to each other.

7. Apparatus as claimed in claim 3 or claim 4, wherein at all cross-sections along their length the strips of each pair are disposed at 90° to each other.

8. Apparatus for mixing two or more fluids, substantially as hereinbefore described with reference to and as illustrated in Figures 1 and 2 of the accompanying drawings.

9. Apparatus for mixing two or more fluids, supbstantially as hereinbefore described with reference to and as illustrated in Figures 3 and 4 of the accompanying drawings.

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1449480 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

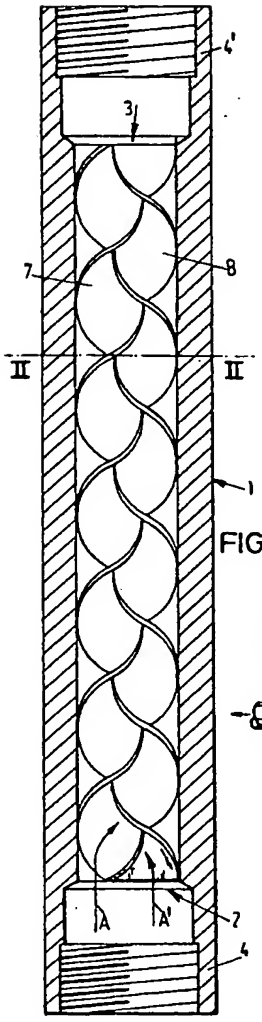

FIG.1

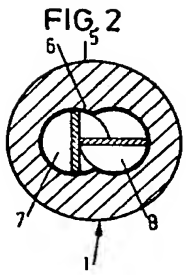

FIG.2

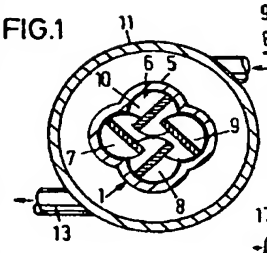

FIG.4

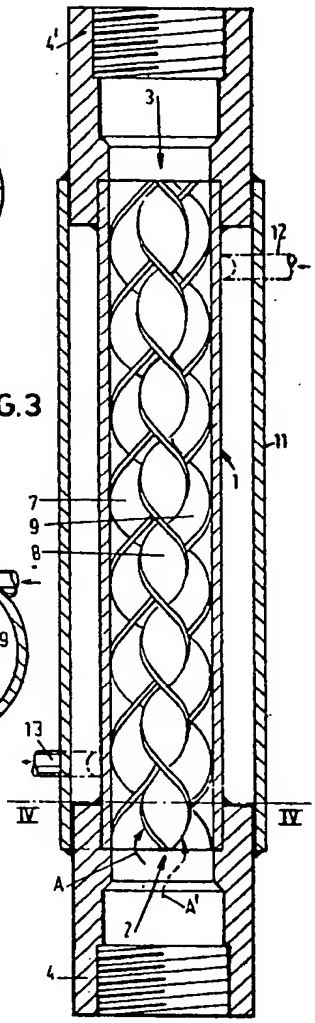

FIG.3